Heterogeneity of Loss Aversion and Expectations-Based Reference Points

Lorenz Goette*
University of Bonn

Thomas Graeber†
University of Bonn

Alexandre Kellogg‡
UC San Diego

Charles Sprenger§
UC San Diego

This Version: April 27, 2018

Abstract

This project examines the role of heterogeneity in loss aversion for identifying models of expectations-based reference dependence (Kőszegi and Rabin, 2006, 2007) (KR). Different levels of loss aversion lead to different signs for comparative statics previously used to test the KR model. In an experiment with 607 subjects, we show heterogeneous treatment effects over loss aversion types. Recognizing heterogeneity in loss aversion allows us to reliably recover the KR model's central element of expectations-based reference points. Additional effects are discussed related to the subjective perception of exchange experiences.

JEL classification: D81, D84, D12, D03

Keywords: Reference-Dependent Preferences, Rational Expectations, Personal Equilibrium, Endowment Effect, Expectations-Based Reference Points

*University of Bonn, Institute for Applied Microeconomics, Adenauerallee 24 - 42, 53113 Bonn, Germany; lorenz.goette@uni-bonn.de

†University of Bonn, Bonn Graduate School of Economics, Kaiserstraße 1, 53113 Bonn, Germany; graeber@uni-bonn.de

‡Department of Economics, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093; alexkellogg@ucsd.edu

§Department of Economics and Rady School of Management, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093; csprenger@ucsd.edu

1 Introduction

Models of reference-dependent preferences are regarded as a major advance in behavioral economics, rationalizing a range of observations at odds with the canonical model of expected utility over final wealth (Kahneman et al., 1990; Camerer et al., 1997; Odean, 1998; Rabin, 2000). Critical to such applications is the formulation of the reference point around which gains and losses are encoded. A recent literature has examined characterizations of the reference point based on rational expectations of potential outcomes (Kőszegi and Rabin, 2006, 2007) (henceforth KR).[1] These expectations-based models have the promise to be readily and broadly applicable, closing the model with a foundation to which economic tools are already adapted.

Despite the promise of the KR formulation of the reference point, tests of the theory have yielded mixed results (see, e.g., Ericson and Fuster, 2011; Heffetz and List, 2014; Goette et al., 2016; Abeler et al., 2011; Gneezy et al., Forthcoming). While early experimental applications in exchange behavior and effort decisions showed treatment effects in line with KR comparative statics, subsequent replications and extensions have shown more limited or null effects.

Our study begins with an observation: within the KR model, heterogeneity in the key behavioral parameter, loss aversion, can confound inference. Given the documented variation in individual measures of loss aversion (see, e.g. Sprenger, 2015; Erev et al., 2008; Harinck et al., 2007; Nicolau, 2012; Sokol-Hessner et al., 2009), this is potentially an issue of first order importance. Failure to account for heterogeneity in loss aversion may well be responsible for some of the conflict noted in the above studies. For example, the baseline experiments of Ericson and Fuster (2011) identify a general unwillingness to exchange a randomly endowed item. This unwillingness is reduced by increasing the probability of being permitted to exchange, consistent with the KR predictions. Using a very similar

[1]Our analysis will focus on the formulations of KR. An earlier literature also provided formulations of reference dependence grounded in rational expectations, but without the equilibrium concepts we analyze (Bell, 1985; Loomes and Sugden, 1986).

design, the initial experiment of Heffetz and List (2014) find a general willingness to exchange that is not influenced by permission probability. Section 2 of this paper clarifies that such results could obtain from differences in the distribution of loss aversion across experiments.[2] Even with a majority of subjects being loss averse, heterogeneity deeply influences the power of any experimental test. Our specific findings on the distribution of loss aversion indicate required sample sizes of around 600 subjects for identifying aggregate KR treatment effects, considerably larger than several of the above-noted experiments.

We design an exchange experiment with the objective of examining the force of expectations-based models while recognizing heterogeneity in loss aversion. Our central treatment plausibly alters expectations of exchange for a given object, and we experimentally control the prior experiences of agents. The manipulation of experience allows us to collect, and validate, a measure of loss aversion for an alternate object, providing an assessment of heterogeneity. Our objective is achieved through between-subjects variation and a purposeful parsimony of choices, with a single binary decision per subject.

We implement our study in a sample of 607 subjects. In a first stage, subjects are randomly endowed with one of two objects. Though no choices are made, subjects are asked to provide ratings of both objects, and their initial mood is measured using standard psychological scales. Subsequently, based on a randomization device, the endowed object is taken away for half of the subjects and replaced with the alternative object, after which mood is measured again. The initial ratings allow us to form a taxonomy of types, constructed from a simple structural model of rating statements.[3] The randomized confiscation and

[2] Naturally, many other ex-post explanations exist. For example, differences in consumption utilities across experiments could outweigh the forces of loss aversion, or apparently small design difference could be amplified in the eyes of subjects.

[3] We also provide reduced form evidence based only on the ratings themselves. The structural model assumes ratings are driven by consumption utilities and loss aversion. Though no choices are made, the core assumption is that subjects rate the object truthfully. The measure of loss aversion estimated is consistent with rational expectations as subjects were not told in advance that their their endowed object may be taken away when the ratings data was collected. An alternative design would attempt to precisely measure loss aversion either through statements of small stakes risk aversion (Fehr and Goette, 2007; Sprenger, 2015) or some other choice. Such tests would require both additional assumptions (e.g., about the correlation between consumption utility and loss aversion) and additional experimental choices. Recognizing both the polluting potential of such choices and the challenge of modeling the full body of

corresponding changes in mood measures provide for an initial validation of our taxonomy, ensuring that people who are classified as loss averse actually do experience sensations of loss in their measured mood.

In a second stage, subjects are again endowed with one of two objects. The second stage objects have no plausible complementarities with either object in the first stage, eliminating the desire to construct bundles of objects across the two stages. In this second stage, subjects make their only choice in the experiment. Forty percent of subjects are asked a baseline endowment effect question of whether they would like to trade their object for the alternative. The other sixty percent of subjects are asked whether they would like to trade their object under a probabilistic forced exchange mechanism akin to Goette et al. (2016). With probability 0.5, regardless of their decision, exchange will be forced. Under the KR model, individuals who are loss averse should grow more willing to exchange relative to baseline when probabilistically forced to do so, while those who are loss loving should grow less willing to exchange (statements which we formalize in section 2).

The second stage provides for two central analyses. First, in the baseline condition we further validate our taxonomy of loss averse types by examining whether individuals coded as loss averse in Stage 1 are also unwilling to exchange for a completely different object in Stage 2. Second, we study expectations-based forces by examining sensitivity of behavior to probabilistic forced exchange. Given these predictions depend upon the heterogeneity in loss aversion, this exercise is conducted separately for the different types identified in Stage 1.

We document three key findings. First, on average subjects do appear to prefer their randomly endowed object in Stage 1, indicating an endowment effect in ratings.[4] Correspondingly, we estimate loss aversion on aggregate. At the individual level 36% of subjects are classified as loss averse, 40% as potentially loss neutral, and 25% as loss loving. Our

experimental behavior through the lens of the KR model (for discussion, see Sprenger, 2015), we opted for this more broad categorization. Failure to correctly categorize types should lead to a lack of predictive validity in Stage 2 of the experiment, working against our identified results.

[4]Forty-seven percent of subjects report a higher rating for their endowed object, twenty-two percent report the same rating, and thirty-one percent report a higher rating for the alternative object.

relative proportion of loss averse and loss loving is comparable to other recent findings on the heterogeneity of loss aversion (Chapman et al., 2017).[5]

Second, the taxonomy of loss aversion is respected in the responsiveness of mood to randomized experience. Loss averse types have significantly larger decreases in mood than loss loving types if their Stage 1 object is confiscated. More compellingly, this taxonomy is respected in Stage 2 behavior. In the Stage 2 baseline condition, loss averse types are less willing to trade than others, delivering a substantial endowment effect for a different, randomly-assigned object.

Third, the comparative statics of expectations-based models are decisively supported in Stage 2. Following KR predictions, loss-averse types grow significantly more willing to trade under probabilistic forced exchange, while loss-loving types grow significantly less-so. Recognizing and accounting for the heterogeneity in types is critical as the aggregate data reproduce the null findings of Goette et al. (2016) for a similar forced exchange mechanism.

We believe our results add to the discussion of reference-dependent preferences and exchange anomalies in general. First, recognizing and accounting for heterogeneity in loss aversion allows for more nuanced tests of expectations-based reference dependence. Given different findings across prior studies (Ericson and Fuster, 2011; Heffetz and List, 2014), the null aggregate effects here and in Goette et al. (2016), and our theoretical development demonstrating that KR comparative statics change sign for different types of loss aversion, heterogeneity appears to be a confound of first order importance. We show, in a simple setting, that the forces of expectations-based models are reliably recovered once heterogeneity in loss aversion is accounted for.

Second, a body of research has questioned the generality of exchange anomalies such as the endowment effect. One line in particular has argued that trading experience can increase

[5] Based on willingness to pay and willingness to accept data for lotteries from a representative sample, Chapman et al. (2017) find an endowment effect for 60% of the respondents, no endowment effect for 10% of the subjects, and a reverse endowment effect for approximately 30% of the sample. Loss averse types in our data are 1.44 times more likely than loss loving types. In their data loss averse types are twice as frequent.

the willingness to engage in exchange (List, 2003, 2004), with the implication that the endowment effect should be 'selected' out in markets. Indeed, Engelmann and Hollard (2010), show that even a very minute body of experience can eliminate the endowment effect. In section 4.3, we link the experiences of Stage 1, and the subjective perception thereof, to exchange behavior in Stage 2. Even accounting for heterogeneity in types, there remains a marked distaste for exchange in Stage 2. This 'residual' endowment effect is related to experience in Stage 1. Interestingly, the effects of experience are not reflected in the objective outcome of keeping or losing one's object, but rather in the subjective perception of this experience.[6] Individuals with a negative perception of their Stage 1 experience are less willing to exchange in Stage 2. Such an observation may help to explain the findings of Engelmann and Hollard (2010). In their study, experience is induced through trading rounds, in which subjects must make an exchange in order to keep *any* object. Making such an explicit connection between exchange and positive experience should indeed lead to more willingness to trade. This also suggests a path by which exchange anomalies may persist: negative experiences (both for exchanging and not exchanging) can lead to less willingness to exchange subsequently. As such, the endowment effect need not be selected quickly out of the market through trading experience alone if perceptions thereof are not uniformly positive.

The paper proceeds as follows. In Section 2, we set the theoretical background and derive behavioral predictions. Section 3 and 4 present the experimental design and results, respectively. Section 5 concludes.

2 Theoretical Considerations and Design Guidance

We examine the forces of expectations-based reference-dependent preferences in simple exchange settings with two goods, recognizing heterogeneity of loss aversion. The theo-

[6] Subjectively, the experience could be positive or negative depending on the subject's loss aversion.

retical development hues closely to our experimental design, providing motivation for our analyses.

Consider a two-dimensional utility function over the two objects of interest, good X and good Y. Let $\mathbf{c} = (m_X, m_Y)$ and $\mathbf{r} = (r_X, r_Y)$ represent vectors of consumption utility and reference utility, respectively. The KR model specifies a utility function with two components, consumption utility, $m(\mathbf{c}) \equiv m_X + m_Y$, and gain-loss utility, $n(\mathbf{c}|\mathbf{r}) \equiv n_X(m_X|r_X) + n_Y(m_Y|r_Y) \equiv \mu(m_X - r_X) + \mu(m_Y - r_Y)$, with separability across consumption dimensions. Let $m_X \in \{0, X\}$ and $m_Y \in \{0, Y\}$ stand for both the outcome and the corresponding consumption utility of owning no or one unit of good X, and no or one unit of good Y, respectively. Overall utility is described by

$$\begin{aligned} u(\mathbf{c}|\mathbf{r}) = u(m_X, m_Y|r_X, r_Y) &= m_X + n_X(m_X|r_X) + m_Y + n_Y(m_Y|r_Y) \\ &= m_X + \mu(m_X - r_X) + m_Y + \mu(m_Y - r_Y), \end{aligned}$$

where

$$\mu(z) = \begin{cases} \eta z & \text{if } z \geq 0 \\ \eta\lambda z & \text{if } z < 0. \end{cases}$$

In this piece-wise linear gain-loss function, the parameter η captures the magnitude of changes relative to the reference point, and λ is the degree of loss aversion.

2.1 Determination of the Reference Point

For the KR model, the vector $\mathbf{r}$ is determined as part of a consistent forward-looking plan for behavior. The KR model posits a reference-dependent expected utility function $U(F|G)$, taking as input a distribution F over consumption outcomes, $\mathbf{c}$, which are valued relative to a distribution G of reference points, $\mathbf{r}$. That is

$$U(F|G) = \int\int u(\mathbf{c}|\mathbf{r}) dF(\mathbf{c}) dG(\mathbf{r}).$$

A *Personal Equilibrium* is a situation where, given that the decision-maker expects as a reference some distribution F, she indeed prefers F as a consumption distribution over all alternative consumption distributions, F'. Ex-ante optimal behavior has to accord with expectations of that behavior. Formally, given a choice set, $\mathcal{D}$, of lotteries, F, over consumption outcomes $\mathbf{c} = (m_X, m_Y)$, *Personal Equilibrium* states the following:

Personal Equilibrium (PE): A choice $F \in \mathcal{D}$, is a personal equilibrium if

$$U(F|F) \geq U(F'|F) \; \forall \; F' \in \mathcal{D}.$$

Regardless of endowment, if good X is to be chosen in a PE, then $\mathbf{r} = (X, 0)$ and if good Y is to be chosen in a PE then $\mathbf{r} = (0, Y)$.

2.1.1 Manipulating r: Probabilistic Forced Exchange

As noted above, the PE concept requires a consistency between $\mathbf{c}$ and $\mathbf{r}$. In a simple exchange experiment over two objects, potential PE selections are $[\mathbf{c}, \mathbf{r}] = [(X, 0), (X, 0)]$ and $[\mathbf{c}, \mathbf{r}] = [(0, Y), (0, Y)]$. Depending on the endowment of X or Y, only one of these choices represents an unwillingness to trade. Assuming an endowment of X, the individual can support not exchanging $[\mathbf{c}, \mathbf{r}] = [(X, 0), (X, 0)]$ in a PE if

$$U(X, 0|X, 0) > U(0, Y|X, 0),$$

or

$$X > \frac{1+\eta}{1+\eta\lambda} Y. \tag{1}$$

Note that the smallest value of X at which the individual can support not exchanging, $\underline{X} = \frac{1+\eta}{1+\eta\lambda} Y$, is inferior to Y if $\lambda > 1$. As such, loss averse individuals can support not exchanging X for Y even if Y would be preferred on the basis of consumption utility alone. This describes the mechanism by which the KR model generates an endowment effect. Figure 1 graphs $\underline{X}$ against λ for $Y = 1$, $\eta = 1$, showing that as λ increases, the lowest value of X at which the agent can support not exchanging decreases following a simple inverse relationship.

Also graphed in Figure 1 is the alternate PE cutoff value corresponding to an agent who fulfills an expectation to exchange their endowed object X for Y.

$$U(0, Y|0, Y) > U(X, 0|0, Y),$$

or

$$X < \frac{1 + \eta\lambda}{1 + \eta} Y.$$

The highest value of X at which the agent can support exchanging, $\overline{X} = \frac{1+\eta\lambda}{1+\eta} Y$, increases linearly with λ. Note that for $\underline{X} < X < \overline{X}$, there will be multiple equilibria, with the agent able to support both exchanging and not exchanging as a PE. The KR model is constructed with a notion of equilibrium refinement, *Preferred Personal Equilibrium* (PPE), in which ex-ante utility is used as a basis for selection and, hence, for making more narrow predictions. We provide our results without appeal to equilibrium selection, assuming only that actions are more likely to be taken if they are PE than if they are not.[7]

Now, consider a setting of probabilistic forced exchange. With probability 0.5 the agent, assumed endowed with X, will be forced to exchange X for Y regardless of their choice. If the individual wishes to retain her object, she is subject to a stochastic reference point, as with probability 0.5 it will be confiscated. She can support attempting not to exchange if

$$U(0.5(X, 0) + 0.5(0, Y)|0.5(X, 0) + 0.5(0, Y)) > U(0, Y|0.5(X, 0) + 0.5(0, Y)),$$

or

$$X > Y. \tag{2}$$

[7] Goette et al. (2016) discuss PPE considerations with probabilistic forced exchange, ensuring that the core comparative statics associated with probabilistic forced exchange are maintained under equilibrium refinement.

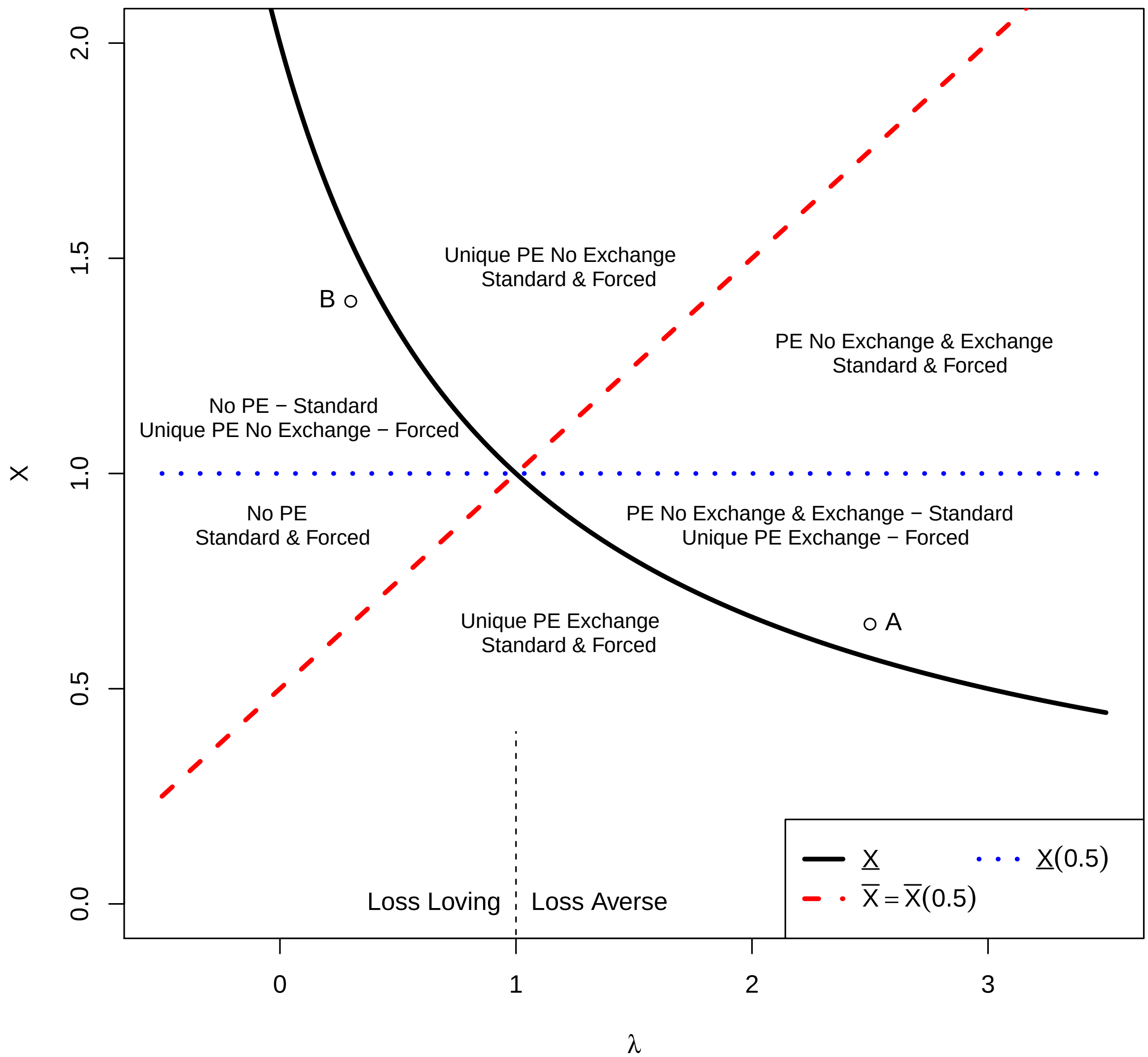

Figure 1: **Loss Aversion and Personal Equilibrium Values**

Notes: PE cutoff values for agent endowed with X, $Y = 1$ and $\eta = 1$. For $X > \underline{X} = \frac{1+\eta}{1+\eta\lambda}Y$, agents can support not exchanging as a PE in standard exchange environment. For $X < \overline{X} = \frac{1+\eta\lambda}{1+\eta}Y$, agents can support exchanging as a PE in a standard exchange environment. With forced exchange probability of 0.5 $\underline{X}(0.5) = Y$ and $\overline{X}(0.5) = \overline{X} = \frac{1+\eta\lambda}{1+\eta}Y$. Endowed with X, loss averse agents with $\lambda > 1$ (as in point A) can support not exchanging in PE in standard exchange environment, but cannot with probabilistic forced exchange. Loss loving agents with $\lambda < 1$ (as in point B) cannot support not exchanging in PE in standard exchange environment, but can with probabilistic forced exchange.

The individual can support attempting to retain X only on the basis of consumption utility values, regardless of the level of loss aversion. The manipulation of probabilistic forced exchange changes the PE cutoff for $\underline{X}$ from $\underline{X} = \frac{1+\eta}{1+\eta\lambda}Y$ to $\underline{X}(0.5) = Y$. Figure 1 illustrates the changing PE cutoff values associated with not exchanging. Loss averse agents can no longer support not exchanging in PE at values of X lower than Y.

Though probabilistic forced exchange alters the PE considerations associated with not exchanging, it leaves unchanged the PE considerations associated with exchanging. The agent can support exchanging in PE if

$$U(0, Y|0, Y) > U(0.5(X, 0) + 0.5(0, Y)|0, Y),$$

which as before is

$$X < \frac{1 + \eta\lambda}{1 + \eta}Y.$$

$\overline{X}(0.5) = \overline{X}$ is noted in Figure 1.

Manipulating forced-exchange probability carries clear value for testing the KR model. Under the standard assumption of loss aversion, $\lambda > 1$, agents can support not exchanging in PE for values of $X < Y$ in a standard exchange experiment, but cannot do so with forced exchange probability of 0.5. The intuition is simple: attempting to retain the object exposes the agent to potential losses under forced exchange. She cannot support accepting these losses. Under the assumption that actions are more likely to be taken if they are PE than if they are not, agents' willingness to exchange should increase with forced exchange. This is a unique prediction of expectations-based models not shared by prior formulations of the reference point. Goette et al. (2016) demonstrate this potential manipulation and its value for testing the KR model based only upon PE considerations. Importantly, this comparative static prediction hinges on agents being loss averse. In the next subsection, we investigate heterogeneity in loss aversion, showing that the comparative static associated with probabilistic forced exchange can reverse sign if individuals have $\lambda < 1$.

2.2 Heterogeneity in Loss Aversion

A number of recent studies have questioned the universality of loss aversion (see, e.g., Sprenger (2015); Erev et al. (2008); Harinck et al. (2007); Nicolau (2012)).[8] Heterogeneity in loss aversion can confound the identification of expectations-based models. Under KR preferences, different values of λ can lead to different directional predictions for the effects of forced exchange. Figure 1 illustrates the logic, graphing the PE cutoff values for not exchanging, $\underline{X} = \frac{1+\eta}{1+\eta\lambda}Y$ and $\underline{X}(0.5) = Y$, and for exchanging, $\overline{X} = \overline{X}(0.5) = \frac{1+\eta\lambda}{1+\eta}Y$.

Consider the case of a point like A, with $\lambda > 1$ and a valuation X slightly below $Y = 1$. In the standard exchange experiment this individual can support not exchanging even though $X < Y$ as $X > \underline{X}$. With forced exchange probability 0.5, this individual can no longer support not exchanging as $X < \underline{X}(0.5)$. Assuming that actions are more likely to be taken when they are PE than when they are not leads to the Goette et al. (2016) comparative static prediction: individuals should grow more willing to exchange with probabilistic forced exchanged.

Now, consider a point like B with $\lambda < 1$ and a value of X slightly above $Y = 1$. Such an individual cannot support not exchanging as a PE in the standard exchange experiment even though $X > Y$ as $X < \underline{X}$.[9] With forced exchange probability of 0.5 this individual can now support not exchanging as a PE as $X > \underline{X}(0.5)$. Again, assuming that actions are more likely to be taken when they are PE than when they are not leads to the opposite prediction from the prior case. An agent with $\lambda < 1$ grows less willing to exchange with probabilistic forced exchange, reversing the sign of the previously described comparative static.[10]

[8] Though $\lambda > 1$ obtains for the majority of subjects, a substantial fraction are found to be close to loss neutral, $\lambda = 1$, and loss loving, $\lambda < 1$.For example, in the individual estimates of Sprenger (2015), 27% of the sample has $\lambda < 1$ within the 95% confidence interval of their estimated λ, while the remaining 73% are significantly loss averse.

[9] This individual can also not support exchanging as a PE given his loss-lovingness as $X > \overline{X}$. That is, no PE selections exist for this individual. KR note the possibility of multiplicity and absence of equilibria in their theoretical development.

[10] Note that the example provided relied on both differences in loss aversion, λ, and consumption utility, X, between points A and B. This is only for illustrative purposes. If two agents instead had the same value of X, either above or below Y, with one being loss averse and the other loss loving, then one of them

Taken together the analysis of probabilistic forced exchange and heterogeneity give insights for our experimental design. Our study adapts Goette et al.'s (2016) central manipulation of probabilistic forced exchange to a binary exchange situation with two objects, and also manipulates prior experiences to deliver and validate measures of loss aversion.[11]

3 Experimental design and procedures

Our design is comprised of two stages. In Stage 1, a taxonomy of loss averse types is created, exchange experience is manipulated via random confiscation, and the effects of this experience on mood are measured. In Stage 2, subjects are assigned to either a standard exchange study or one with probabilistic forced exchange, making their only choice in the experiment. Stage 1 experiences and measures of loss aversion can then be connected to Stage 2 behavior. Figure 2 illustrates the experimental order of events.

3.1 Stage 1: Measures of Loss Aversion and Manipulation of Experience

Procedures. The experimenter welcomed the participants in a small presentation room and informed them that the study would consist of two stages. At each seat there was a card with a number (placed face down). Then, without further explanation, the experimenter projected on the wall two equally-sized pictures of the respective Stage 1 objects for that session along with the description and two short bullet points on the characteristics of the product. The exact information presented to subjects is reproduced in Appendix C.

would be affected by probabilistic forced exchange (either positively or negatively) and the other would not. This implies that if X is symmetrically distributed around Y, and X and λ are independent, the sign of comparative statics can differ depending on whether $\lambda > 1$ or $\lambda < 1$. Loss averse agents will grow more willing to exchange on average while loss loving agents will grow less willing to exchange on average as exchange is probabilistically forced.

[11] Unlike Goette et al. (2016), we also study a direct exchange mechanism that does not require eliciting the willingness to pay or willingness to accept in monetary terms using price lists.

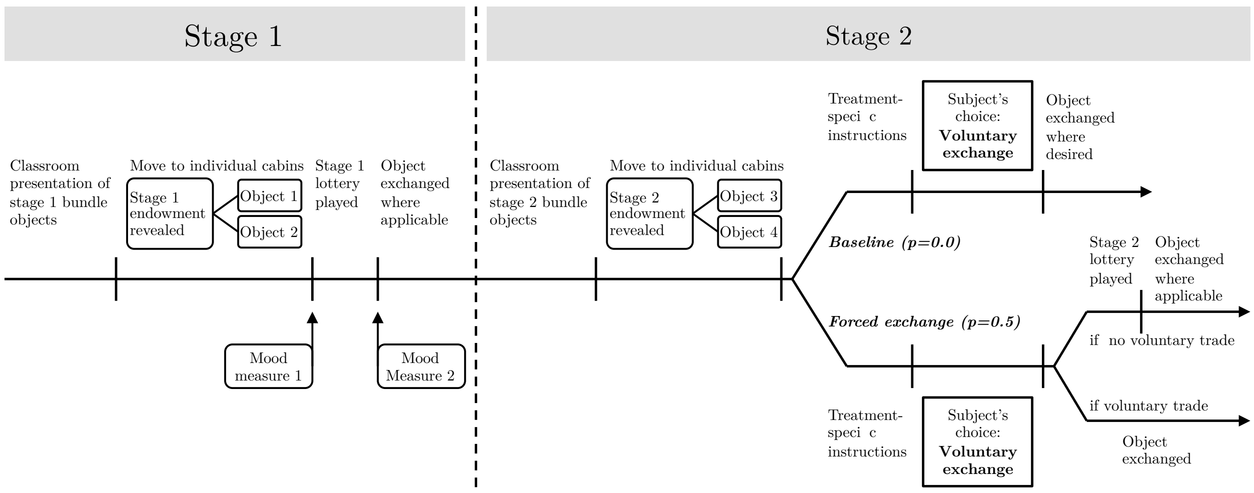

Figure 2: **Timeline of Laboratory Experiment**

Notes: The figure displays the course of events in both treatment conditions, baseline ($p = 0.0$) and forced exchange ($p = 0.5$).

After allowing sufficient time (three minutes) to study the projected information, the experimenter asked subjects to turn the card in front of them over and move to the cubicle with the corresponding number in the adjacent computer laboratory. In their private cubicle, which was separated and not visible from the outside, subjects would find one of the two presented goods. Computer instructions then informed the subject that she possesses the object in front of her, and that she is free to inspect it more closely.

After three minutes allotted for inspection of the good, we asked subjects how much they liked and wanted each one of the goods. Specifically, for each object we asked "How much do you like this product?" and "How much would you want to have this product?" with response scales ranging from 0="Not at all" to 8="Very much". These ratings data are used to construct our measures of loss aversion, notably collected without experimental choice. These ratings are collected before any further instructions are given, including instructions related to confiscation.

Next, the computer instructions announced that the experimenter would randomly draw a number between 1 and 20 using a rotating lottery drum placed on a table in the middle of the room. Half of the subjects learned that they would lose their current good and receive the other one in return in case a number between 1 and 10 is drawn. Instructions for the other half read that this exchange would only take place if a number between 11 and 20 is drawn.[12] The experimenter drew the number in a way that both the lotto device containing the 20 balls and the drawn number was visible from every cabin. The exchange was executed after the draw by the experimenter, who, without further comment, replaced the object for subjects who had lost their good due to the drawn number. Subsequent instructions informed subjects that they would keep their current object and asked them to return to the lecture room for the second stage.

Immediately before and immediately after the random confiscation was conducted, we elicited subjects' mood using standard psychological scales (Bradley and Lang, 1994). Subjects answered the question "Please answer the following questions about how you currently feel. Which expressions better apply to you at the moment?" by positioning a slider on an 11-point response scale. The lower end (0) was labeled using the words "Unhappy, Angry, Unsatisfied, Sad, Desperate" and the upper end (10) was labeled "Happy, Thrilled, Satisfied, Content, Hopeful". The individual change in these scores are used to provide an initial validation of our taxonomy of types.

3.2 Stage 2: Probabilistic Forced Exchange, Heterogeneity and Prior Experience

Procedures. The basic procedures in the second stage were deliberately kept exactly identical to those in the first stage. Upon their return to the lecture room, the experimenter projected another page onto the wall, this time presenting the objects of the Stage 2 goods bundle of that session. In the meantime, a second experimenter allocated objects to the cubicles in the computer laboratory next door in a pre-specified order. Subjects were ushered back to their cubicle where again they found their second object, learned

[12]This *loss condition* was counterbalanced within each subsample endowed with the same good, such that irrespective of the draw, exchange would take place for exactly half of the subjects initially endowed with either good.

that it belonged to them and were allowed sufficient time for inspection. We studied two conditions.

Baseline treatment. In the baseline condition, subjects received an opportunity to voluntarily exchange their endowed good for the other one. Whichever way they chose, they would keep or receive their desired object and there would be no further exchange. The baseline condition is a standard exchange setting.

Forced exchange treatment. The second condition implemented an exchange study with probabilistic forced exchange. The instructions specified that irrespective of their choice of exchanging their endowed object, exchange would take place anyway with a probability of 50% based on a draw from the lotto drum as in the first stage. This means that for a subject who decided to trade voluntarily, the forced exchange did not bear any consequences. However, for a subject who chose to keep her object, there was an additional chance of losing it.

Several noted issues with experimental investigations of market exchange motivated our purposefully simple design (Plott and Zeiler, 2005, 2007). First, subjects take a simple binary choice, alleviating potential concerns related to the use of 'multiple price lists' in exchange experiments. Specifically, we do not need to elicit a willingness to pay or willingness to accept in monetary terms, but simply ask whether the subject is willing to trade the endowed good for the other one. As such, mistaken perceptions of market power do not play a role, nor do income effects. Second, unlike previous market exchange experiments, we create a private environment that limits confounds from social interaction. In particular, subjects take their decisions anonymously in a private cabin; they find their endowment placed in front of them when entering the cabin instead of receiving it personally through the hands of the experimenter (which has been criticized for triggering the misperception of the endowment as a gift (see, e.g., Plott and Zeiler, 2005, 2007)); and subjects do not interact with other subjects at any stage during the experiment.

3.3 Sample Details

A sample of 607 students from the University of Bonn participated in the experiment which was conducted using the software z-Tree (Fischbacher, 2007) in June and July 2015 at the BonnEconLab. We conducted 31 sessions with 17 to 20 participants each. Table 1 provides an overview of the subject pool by treatment conditions.

Table 1: **Summary Statistics and Treatment Assignment**

Stage 1

	Bundle 1		Bundle 2	
	USB stick	Pen set	Picnic mat	Thermos
A) Initial Endowment	160	152	150	145
– in % of subject pool	26.36%	25.04%	24.71%	23.89%
B) Lost Endowment	80	76	75	72
– in % of A)	50.00%	50.00%	50.00%	49.66%

Stage 2

	Bundle 1		Bundle 2	
	USB stick	Pen set	Picnic mat	Thermos
C) Initial Endowment	150	145	160	152
– in % of subject pool	24.71%	23.89%	26.36%	25.04%
D) Baseline Condition	60	58	60	55
– in % of C)	40.00%	40.00%	37.50%	36.18%
E) Probability 0.5 Condition	90	87	100	97
– in % of C)	60.00%	60.00%	62.50%	63.82%
Total number of observations	607			

Notes: Stage 2 condition (baseline or probability 0.5 of forced exchange) is randomized within each session. The use of each bundle as the Stage 1 bundle was counterbalanced at the session level.

The objects used for the exchange experiment included a USB stick, a set of three erasable pens, a picnic mat and a thermos.[13] We selected these four objects on the basis of a pre-experimental survey evaluation of 12 candidate goods to ensure that all items were of approximately equal value to potential participants. We put particular emphasis on ruling

[13]Pictures and information presented to subjects are reproduced in Appendix C.

out complementarities between items across rounds. The former two (USB stick and pens) and the latter two objects (picnic mat and thermos) each constituted a bundle. Every subject faced exactly one exchange situation with each bundle of objects. The use of each bundle as Stage 1 bundle was counterbalanced at the session level, with the respective other bundle used in Stage 2. Within each session, the endowments of one of the two objects within the bundle was counterbalanced in both stages.[14]

4 Experimental results

We present the results in three subsections. First, we examine stated good ratings and the effect of experience in Stage 1, providing our taxonomies of loss averse types and validating these taxonomies with evidence on the change in mood induced by forced exchange. Second, we examine behavior in Stage 2, linking heterogeneity in loss aversion to probabilistic forced exchange. A third subsection is dedicated to the effects of subjective experience on exchange behavior.

4.1 Stage 1: Loss Aversion, Experience, and Mood

Though no choices were made in Stage 1, we collect two pieces of evidence. First, subjects provide their ratings for both objects. Second, subjects provide a measure of mood once before being informed about the randomized confiscation procedure and once after they learned their random outcome and the exchange was carried out where applicable.

Figure 3 provides histograms of subject's liking of their endowed and the alternative object. Given random assignment of endowed objects and the counterbalanced design, the distributions of ratings should be identical. Instead, the distribution of ratings for sub-

[14] That is, if for a given session the USB stick and pens bundle constituted the first stage bundle, the picnic mat and thermos bundle would be the second stage bundle. Half of the subjects were initially endowed with the USB stick in the first stage. Among this half of the session participants, again half would initially receive the picnic mat and the other half the thermos at the beginning of the second stage.

jects' own object skews higher than the alternative, yielding a statistically significant stated preference for the endowed good (Wilcoxon signed-rank test, $z = 4.57$ ($p < 0.01$)).

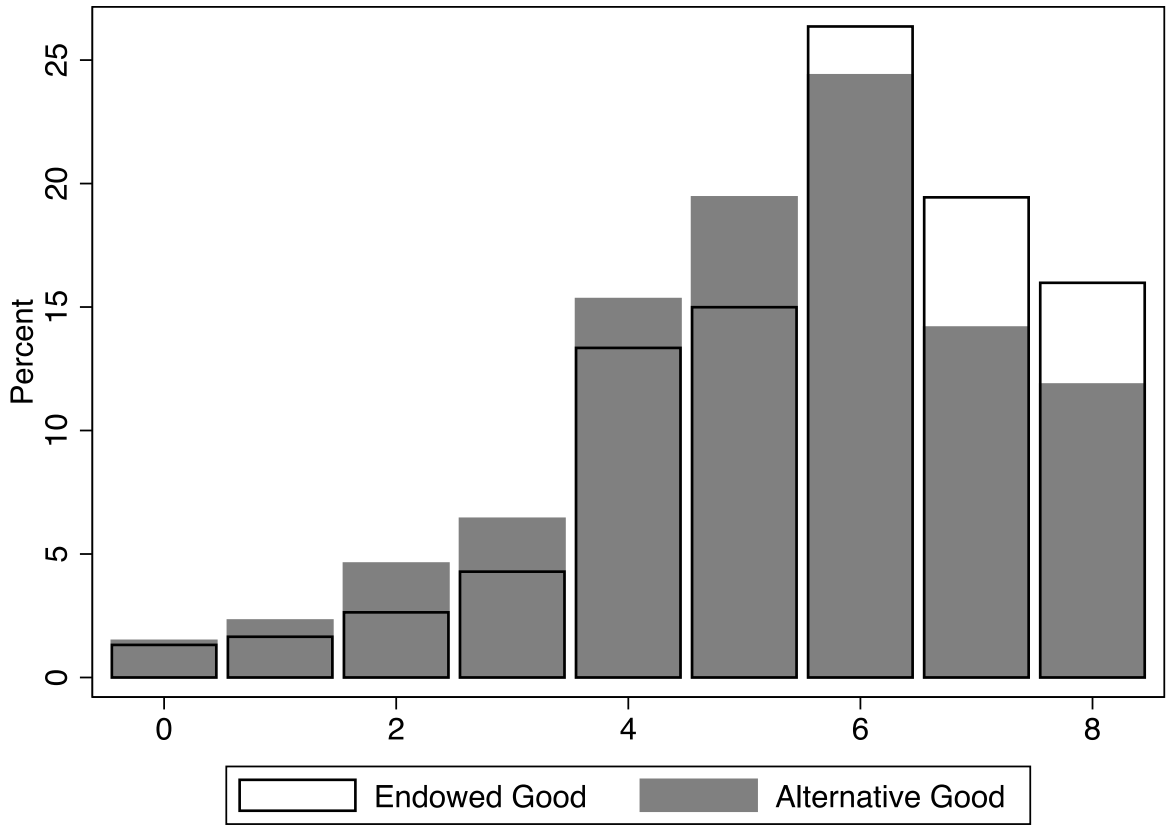

Figure 3: **Preferences and Endowments**
Notes; Self-reported scores of liking for the endowed and alternative goods. (Wilcoxon signed-rank statistic $z = 4.57$ ($p < 0.01$), N=607).

Within subject we also find a tendency towards preferring the endowed object relative to the alternative. Forty-seven percent of subjects report a higher liking score for their endowed object, twenty-two percent report the same score, and thirty-one percent report a higher score for the alternate object.[15]

The liking scores for the endowed and alternative object provide a basis for measuring loss aversion at the aggregate and individual level. We construct a simple structural model of

[15] Our design also collects a score for 'wanting' each object. The corresponding percentage shares for wanting scores are virtually identical (48%, 23%, 29%, respectively). For analysis using these wanting scores as the basis of analysis see Figure A1, Table A2, and Table A3.

these ratings based upon standard random utility methods (McFadden, 1974). Consider an individual endowed with X that is asked to provide ratings statements for both X and Y prior to being informed of the random confiscation implemented in Stage 1. Through the lens of the KR model such an individual evaluates X based upon $U(X, 0|X, 0)$. Given that the agent is endowed with X and is uninformed of the possibility of confiscation at the time of the ratings, she plausibly evaluates Y based upon $U(0, Y|X, 0)$. With standard logit shocks, ϵ_X and ϵ_Y, the parameters associated with these utilities are easily estimated. Unlike choice data, agents may provide the same rating score for both objects. As such, the estimator must account for identical ratings, something to which standard logit techniques are also already well adapted (see, e.g Cantillo et al., 2010). We assume agents will provide a higher rating for their endowed object, X, if

$$U(X, 0|X, 0) + \epsilon_X > U(0, Y|X, 0) + \epsilon_Y + \delta,$$

where δ is a discernibility parameter to be estimated. Similarly agents provide a higher rating for the alternative object, Y, if

$$U(0, Y|X, 0) + \epsilon_Y > U(X, 0|X, 0) + \epsilon_X + \delta,$$

and provide the same rating if

$$|U(X, 0|X, 0) + \epsilon_X - (U(0, Y|X, 0) + \epsilon_Y)| \leq \delta.$$

Under the functional form assumptions of $\eta = 1$ and $m_X = X, m_Y = Y$, for someone given object X, we obtain familiar probabilities for the ranking of ratings $R(X)$ and $R(Y)$,

$$\begin{aligned}
P(R(X) > R(Y)) &= \frac{\exp(U(X, 0|X, 0))}{\exp(U(X, 0|X, 0)) + \exp(U(0, Y|X, 0) + \delta)} = \frac{\exp(X)}{\exp(X) + \exp(2Y - \lambda X + \delta)} \\
P(R(Y) > R(X)) &= \frac{\exp(U(0, Y|X, 0))}{\exp(U(0, Y|X, 0)) + \exp(U(X, 0|X, 0) + \delta)} = \frac{\exp(2Y - \lambda X)}{\exp(X + \delta) + \exp(2Y - \lambda X)} \\
P(R(X) = R(Y)) &= 1 - P(R(X) > R(Y)) - P(R(Y) > R(X)),
\end{aligned}$$

where the consumption utilities values, X and Y, the discernibility parameter δ, and the loss aversion parameter, λ, are the desired estimands. For someone endowed with object Y, these same ratings probabilities are

$$
\begin{aligned}
P(R(X) > R(Y)) &= \frac{\exp(U(X,0|0,Y))}{\exp(U(X,0|0,Y)) + \exp(U(0,Y|0,Y)+\delta)} = \frac{\exp(2X-\lambda Y)}{\exp(Y+\delta)+\exp(2X-\lambda Y)} \\
P(R(Y) > R(X)) &= \frac{\exp(u(0,Y|0,Y))}{\exp(U(0,Y|0,Y)) + \exp(U(X,0|0,Y)+\delta)} = \frac{\exp(Y)}{\exp(Y)+\exp(2X-\lambda Y+\delta)} \\
P(R(X) = R(Y)) &= 1 - P(R(X) > R(Y)) - P(R(Y) > R(X)).
\end{aligned}
$$

The likelihood contribution of someone endowed with X or Y follows precisely the formulations above. It will not generally be possible to estimate both utility values, X and Y, separately. So we normalize one of the goods values to be $Y = 1$ and estimate the remaining parameters via maximum likelihood.

Table 2 provides aggregate estimates of consumption utilities, λ and δ, separately for each bundle of goods. For Bundle 1, we restrict the utility value of USB sticks to be $Y = 1$ and for Bundle 2 we restrict the utility value of the thermos to be $Y = 1$. Quite similar results obtain across the two bundles. For Bundle 1, λ is estimated to be 1.559 (robust s.e = 0.139), while for Bundle 2 it is estimates to be 1.289 (0.121). For both bundles we reject the null hypothesis of no loss aversion $\lambda = 1$, consistent with the reduced form ratings results.[16] The utility of pen sets and picnic mats are estimated to be lower than those of USB sticks and Thermoses, respectively. And, discernibility is estimated close to $\delta = 0.5$ in both cases.

The aggregate estimates show evidence of loss aversion. To construct bounds for estimates of individual loss aversion, we evaluate individual choices assuming average utility and discernibility values. For example, consider an individual endowed with the pen set in Bundle 1. At the aggregate estimates of δ and X for Bundle 1, if this individual were to state a higher ranking for the pen set than for the USB stick, it would imply a loss

[16] For Bundle 1, the null hypothesis of $\lambda = 1$ is rejected, $\chi^2(1) = 16.13,\ (p < 0.01)$. For Bundle 2, the null hypothesis of $\lambda = 1$ is also rejected, $\chi^2(1) = 5.73,\ (p < 0.05)$.

Table 2: **Aggregate Parameter Estimates**

	(1)	(2)	(3)	(4)
	Estimate	(Std. Error)	Estimate	(Std. Error)
	Bundle 1		*Bundle 2*	
Loss Aversion:				
$\hat{\lambda}$	1.559	(0.139)	1.289	(0.121)
Utility Values:				
$\hat{X}_1$ *(Pen Set)*	0.632	(0.049)		
$\hat{Y}_1$ *(USB Stick)*	1	-		
$\hat{X}_2$ *(Picnic Mat)*			0.837	(0.051)
$\hat{Y}_2$ *(Thermos)*			1	-
Discernibility:				
$\hat{\delta}$	0.549	(0.061)	0.446	(0.052)

Notes: Maximum likelihood estimates. Robust standard errors in parentheses.

aversion parameter of $\hat{\lambda} > 3.03$.[17] Similarly, stating a higher ranking for the USB stick would imply $\hat{\lambda} < 1.30$,[18] and stating the same ranking implies $\hat{\lambda} \in [1.30, 3.03]$. Of these three possible cases, two demonstrate evidence of loss aversion $\hat{\lambda} > 1$, while the other case is plausibly loss neutral as $\hat{\lambda} = 1$ can rationalize the rankings.[19] In total, there exist twelve cases of endowments and rank orders. Table 3 enumerates the cases and the corresponding categorization into loss averse, loss neutral, and loss loving types. Overall 217 subjects (35.7%) are categorized as loss averse, 240 (39.5%) are categorized as loss neutral, and 150 (24.7%) are categorized as loss loving. This is the taxonomy of individual types used in our analysis.

The inequalities of Table 3 can be aggregated to construct an implied cumulative distribution function (cdf) for λ. For example, the fact that 42 of 152 (27.6%) subjects endowed

[17]To state a higher ranking for the pen set implies $0.632 > 2 - \hat{\lambda} * 0.632 + 0.549$ or $\hat{\lambda} > 3.03$.

[18] To state a higher ranking for the USB implies $2 - \lambda * 0.632 > 0.632 + 0.549$ or $\lambda < 1.30$.

[19]It may seem prima-facie surprising that providing the same ranking in this case is consistent with loss aversion. The logic is simple: given that the pen set has substantially lower consumption utility than the USB stick, one must be loss averse to rank them equally.

Table 3: **Individual Classifications**

Case	#Obs	*Structural Bounds Taxonomy*			*Reduced Form Taxonomy*		
		Loss Averse	*Loss Neutral*	*Loss Loving*	*Loss Averse*	*Loss Neutral*	*Loss Loving*
Bundle 1							
Endowed Pen Set							
R(Pen Set) > R(USB Stick)	42	$\hat{\lambda} > 3.03$			X		
R(USB Stick) > R(Pen Set)	69		$\hat{\lambda} < 1.30$				X
R(USB Stick) = R(Pen Set)	41	$1.30 \leq \hat{\lambda} \leq 3.03$				X	
Endowed USB Stick							
R(USB Stick) >R(Pen Set)	109		$\hat{\lambda} > 0.81$		X		
R(Pen Set) > R(USB Stick)	23			$\hat{\lambda} < -0.29$			X
R(USB Stick) = R(Pen Set)	28			$-0.29 \leq \hat{\lambda} \leq 0.81$		X	
Bundle 2							
Endowed Picnic Mat							
R(Picnic Mat) > R(Thermos)	55	$\hat{\lambda} > 1.92$			X		
R(Thermos) > R(Picnic Mat)	61			$\hat{\lambda} < 0.86$			X
R(Thermos) = R(Picnic Mat)	34		$0.86 \leq \hat{\lambda} \leq 1.92$			X	
Endowed Thermos							
R(Thermos) > R(Picnic Mat)	79	$\hat{\lambda} > 1.12$			X		
R(Picnic Mat) > R(Thermos)	38			$\hat{\lambda} < 0.23$			X
R(Thermos) = R(Picnic Mat)	28		$0.23 \leq \hat{\lambda} \leq 1.12$			X	
Totals:	607	217	240	150	285	131	191

Notes: Structural bounds taxonomy of types based on individual rankings at estimated aggregate utility values and discernibility parameters from Table 2. Reduced form taxonomy derived from whether subject exhibits higher, lower, or equal rankings for their endowed good relative to the alternative.

with the pen set prefer the pen set gives an estimate that 72.4% of the population has $\lambda < 3.03$. Similarly, the fact that 69 of 152 subjects with the same endowment prefer the USB stick gives an estimate that 45.4% of the population has $\lambda < 1.30$. In total there are 8 such inequalities (one for each strict ranking) that carry implications for the distribution of loss aversion. Figure 4, Panel A aggregates these statements to construct the implied cdf. The statements are generally internally consistent across conditions, with only one small non-monotonicity.[20] The 50th percentile of loss aversion lies around 1.5, in line with the aggregate estimates, and around 55% of probability mass lies above $\lambda = 1$. Because we can only summarize a portion of the cdf (around 0.6 of the total), we provide a quadratic projection based on the 8 data points, indicating a plausible range of loss aversion below $\lambda = 5$. Figure 4, Panel B also provides a histogram of loss aversion based

[20] Of the 145 subjects endowed with a thermos, 79 prefer the thermos to the picnic mat. This implies that 1-(79/145) = 45.5% of subjects have $\lambda < 1.12$. This generates a slight non-monotonicity relative to the 69 of 152 subjects endowed with a pen set that prefer the USB stick, which implies that 69/152 = 45.4% of subjects have $\lambda < 1.30$. This small inconsistency is most likely due to sampling variation given the proximity in the loss aversion parameters.

on the lower bound (upper bound, midpoint) of the range of λ indicated by a subject rating their endowed good higher than (lower than, equal to) the alternative. Again the majority of observation (52.7%) lie above $\lambda = 1$. Though our analysis focuses on the strict measurement of loss aversion noted above, we do benchmark the magnitude of our results to predictions based on these exact values in section 4.2.

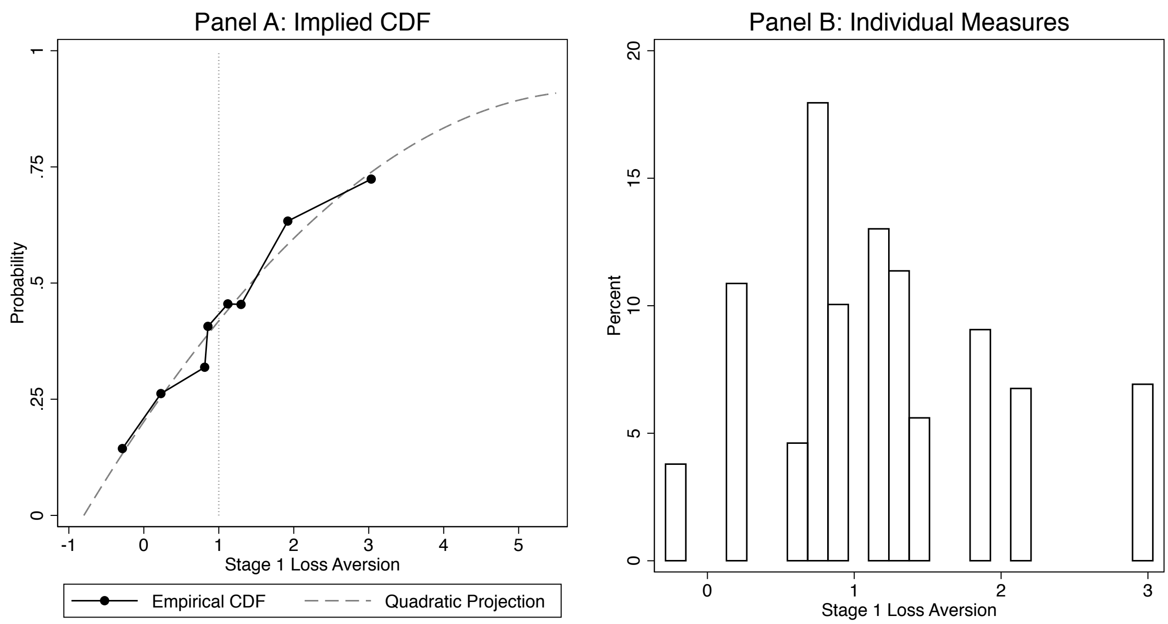

Figure 4: **Distribution of Loss Aversion**

Notes: Panel A provides implied cumulative distribution function (cdf) for loss aversion based on inequalities in Table 3. Each point represents an in inequality implied by one of 8 strict preference statements. Quadratic projection based on 8 cdf points. Panel B provides individual measures of loss aversion for each subject. Measures is based on either the lower bound (upper bound, midpoint) of the range of λ indicated by a subject's choice.

Also presented in Table 3 is an alternate taxonomy based only on raw ranking information. Ignoring utility values and discernibility, this reduced form taxonomy codes someone as loss averse, neutral, or loving depending only on whether the individual provides a higher, equal, or lower ranking for their endowed object. Based on this reduced form taxonomy, 285 subjects (47%) are categorized as loss averse, 131 (22%) are classified as loss neutral, and 191 (31%) are classified as loss loving.[21] Though the structural taxonomy provides a

[21] This follows exactly the relative rankings data noted above.

more conservative classification of types, there is broad agreement between the structural and reduced form taxonomies (Pearsons $\chi^2(4) = 315.2$, $(p < 0.01)$). For completeness, we provide all our analysis with both the structural and reduced form bounds provided in Table 3.

Table 4: **Preference Types and Subjective Experience**

	(1)	(2)	(3)	(4)
	Dependent Variable: Δ Stage 1 Happiness			
	Full Sample	Loss Averse	Loss Neutral	Loss Loving
Panel A: Structural Bounds Taxonomy				
Lost Stage 1 Endowment	-0.826***	-2.679***	-0.715**	1.560***
	(0.210)	(0.385)	(0.291)	(0.403)
Constant	0.582***	1.198***	0.715***	-0.818**
	(0.159)	(0.254)	(0.231)	(0.337)
R-Squared	0.0249	0.252	0.0106	0.129
# Observations	607	217	240	150
Panel B: Reduced Form Taxonomy				
Lost Stage 1 Endowment	-0.826***	-3.169***	-0.443	2.454***
	(0.210)	(0.282)	(0.420)	(0.303)
Constant	0.582***	1.841***	0.226	-1.264***
	(0.159)	(0.194)	(0.319)	(0.256)
R-Squared	0.025	0.308	0.009	0.265
# Observations	607	285	131	191

Notes: Ordinary least squares or two-stage least squares regression. Robust standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Panel A: taxonomy of types based on structural bounds from Table 3. Panel B: taxonomy of types based on reduced form rating statements from Table 3.

A minimal validation to eschew random response and lend credence to our two classifications is provided by our mood measures. Table 4 provides a summary of reported mood regressing the change in Stage 1 Happiness, Δ *Stage 1 Happiness*, on the objective experience of losing one's object for the full sample and our different identified types. Panel A presents the results based on the structural taxonomy, while Panel B uses the reduced form classification of types. For both taxonomies, individuals categorized as loss averse have substantial deterioration in mood if they lose their endowment, while individuals categorized as loss loving grow happier. Individuals categorized as loss neutral experience intermediate effects, growing somewhat less happy when their endowment is lost. This initial validation indicates that random response is unlikely to be driving our ratings statements, and provides evidence supporting our structural classification.

4.2 Stage 2: Heterogeneous Treatment Effects

Our Stage 2 design relies on between subjects variation. Forty percent of subjects participate in a baseline standard exchange study, choosing whether to keep their endowed object or exchange for the alternative. The other sixty percent make the same choice but with probability 0.5 exchange is forced. Table 5 presents the choices of subjects across these two conditions with linear probability models for the effect of treatment assignment on an indicator, $Exchange(=1)$.[22]

Before turning to the effects of probabilistic forced exchange, we examine behavior in our baseline design. Baseline results are conveyed as the estimated constants in least squares regression of exchange behavior in Table 5. Overall 36.5 percent of subjects choose to exchange, demonstrating a significant endowment effect relative to the null hypothesis of fifty percent exchange, $F_{1,605} = 18.32$, $(p < 0.01)$. A second validation of our taxonomies is derived from examining differential baseline behavior across types. Panel A of Table 5 shows that 33 percent of subjects coded as loss averse according to our structural model choose to exchange, yielding a significant endowment effect relative to 50 percent exchange, $F_{1,215} = 12.21$, $(p < 0.01)$. The fraction of subjects exchanging increases monotonically from loss averse to loss loving types. 42.9 percent of subjects who are coded as loss loving choose to exchange, which cannot be differentiated from the 50 percent benchmark, $F_{1,148} = 1.15$, $(p = 0.29)$. Similar conclusions are reached in Panel B of Table 5, based

[22]The analysis of Table 5 is conducted with robust standard errors. Table A1 repeats this analysis with standard errors clustered at the session level. The statistical conclusions are unchanged. The results based on the structural taxonomy of types increase in statistical significance, while the results based on the reduced for taxonomy decrease in significance when clustering at the session level. Given our focus on the structural taxonomy, Table 5 represents the more conservative set of conclusions.

Table 5: **Exchange Behavior and Probabilistic Forced Exchange**

	(1)	(2)	(3)	(4)
	Dependent Variable: Exchange (=1)			
	Full Sample	Loss Averse	Loss Neutral	Loss Loving
Panel A: Structural Bounds Taxonomy				
Forced Exchange	0.004	0.158**	0.0271	-0.248***
	(0.040)	(0.067)	(0.066)	(0.078)
Baseline Exchange (Constant)	0.365	0.330	0.361	0.429
	(0.032)	(0.049)	(0.053)	(0.067)
R-Squared	0.000	0.025	0.001	0.072
# Observations	607	217	240	150
H_0: No Baseline Endowment Effect	$F_{1,605}$=18.32	$F_{1,215}$=12.21	$F_{1,238}$=6.85	$F_{1,148}$=1.15
	($p < 0.01$)	($p < 0.01$)	($p < 0.01$)	($p = 0.29$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=27.48	$F_{1,215}$=0.07	$F_{1,238}$=8.14	$F_{1,148} = 63.77$
	($p < 0.01$)	($p = 0.78$)	($p < 0.01$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 1.45$
				($p = 0.23$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 15.89$
				($p < 0.01$)
Panel B: Reduced Form Taxonomy				
Forced Exchange	0.004	0.119**	-0.030	-0.149**
	(0.040)	(0.057)	(0.088)	(0.074)
Baseline Exchange (Constant)	0.365	0.304	0.392	0.448
	(0.032)	(0.043)	(0.069)	(0.061)
R-Squared	0.000	0.015	0.001	0.022
# Observations	607	285	131	191
H_0: No Baseline Endowment Effect	$F_{1,605}$=18.32	$F_{1,283}$=20.65	$F_{1,129}$=2.45	$F_{1,189}$=0.73
	($p < 0.01$)	($p < 0.01$)	($p = 0.12$)	($p = 0.39$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=27.48	$F_{1,283}$=4.04	$F_{1,129}$=6.45	$F_{1,189} = 23.82$
	($p < 0.01$)	($p = 0.045$)	($p = 0.012$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 3.71$
				($p = 0.054$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 8.32$
				($p < 0.01$)

Notes: Ordinary least square regression. Robust standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Null hypotheses tested for 1) zero baseline endowment effect, regression (Constant = 0.5); 2) zero forced exchange endowment effect (Constant + Forced Exchange = 0.5); 3) Identical baseline behavior across loss averse and loss loving agents (Constant (col. 2) = Constant (col. 4)); 4) Identical treatment effects of forced exchange across loss averse and loss loving agents (Forced Exchange (col. 2) = Forced Exchange (col. 4)). Hypotheses 3 and 4 tested via seemingly unrelated regression. Panel A: taxonomy of types based on structural bounds from Table 3. Panel B: taxonomy of types based on reduced form rating statements from Table 3.

only on the reduced form classification of types. These qualitative differences in Stage 2 baseline exchange behavior are closely in line with theoretical predictions — loss averse agents are unwilling to exchange, while loss loving types are more eager too — further validating the Stage 1 taxonomies. It must be noted, however, that though the groups differentially deviate from the 50 percent benchmark, the difference-in-differences does not fall within standard measures for statistical significance for either the structural, $p = 0.23$, or reduced form, $p = 0.05$, taxonomies.

Behavior in conditions with probabilistic forced exchange is also reported in Table 5, separately for the different types of agents. Probabilistic forced exchange yields substantially different effects across types of loss aversion. Panel A documents that subjects who are coded as loss averse increase their exchange probability by nearly 16%-age points ($\sim$ 50 percent), under probabilistic forced exchange, $F_{1,215} = 5.64,\ (p < 0.05)$. The sizable endowment effect from baseline is eliminated, such that exchange can no longer be differentiated from the 50 percent benchmark, $F_{1,215} = 0.07,\ (p = 0.78)$.

The positive treatment effect for loss averse types is mirrored by a significant negative treatment effect for loss loving types. Subjects coded as loss loving decrease their exchange probability by nearly 25%-age points ($\sim$ 60 percent), under probabilistic forced exchange, $F_{1,148} = 10.18,\ (p < 0.01)$.[23] The heterogeneous treatment effect over types closely follows our theoretical development on the sign of comparative statics, and is significant at all conventional levels, $\chi^2(1) = 15.89,\ (p < 0.01)$. Quite similar results are found in Panel B, basing the analysis only on the reduced form taxonomy. Loss averse agents respond to forced exchange by exchanging more often while loss loving agents respond by exchanging less often.

Figure 5 presents more granular analysis of treatment. For each of the twelve structural types identified in Table 3, we take as a measure of loss aversion the lower bound (upper bound, midpoint) for those subjects who provided a higher (lower, equal) ranking for their

[23] Given these worsened attitudes towards exchange, loss loving agents in the forced exchange condition deliver a substantial endowment effect relative to the 50 percent benchmark, $F_{1,148} = 63.77,\ (p < 0.01)$.

endowed object relative to the alternative in Stage 1. Figure 5 graphs these values of loss aversion against each group's treatment effect noting the classification of type. The size of each point corresponds to the number of observations. An effectively monotonic pattern of treatment effects is observed. All four groups coded as loss loving exhibit negative treatment effects, all four groups coded as loss neutral deliver effectively zero treatment effect, and all four groups coded as loss averse exhibit positive treatment effects. Even within loss averse and loss loving groups, subjects coded as more loss averse respond more positively to forced exchange.

Also graphed in Figure 5 are predicted treatment effects for each group. At the corresponding values of λ and aggregate utility values, we predict the probability of exchange following closely the logit formulation elaborated in section 4.1.[24] Given that these treatment effects will depend on Stage 2 assignment, and the corresponding aggregate utility values, Figure 5 also provides a locally weighted smoothed prediction. The magnitude of observed treatment effects are broadly in line with those predicted from the structural analysis of Stage 1 behavior.

[24] This formulation maps PE values to choices via the assumption that an agent will exchange based on the probability that they cannot support not exchanging as a PE. For someone endowed with good X in the baseline condition, the exchange probability is thus calculated as the probability of choosing Y:

$$P(Choice = Y)_{Baseline} \quad = \quad \frac{\exp\left(U(0,\hat{Y}|X,0)\right)}{\exp(U(0,\hat{Y}|X,0)) + \exp(U(X,\hat{0}|X,0))} = \frac{\exp(2\hat{Y} - \hat{\lambda}\hat{X})}{\exp(\hat{X}) + \exp(2\hat{Y} - \hat{\lambda}\hat{X})},$$

where X and Y are the aggregate utility values for the goods in question estimate in Table 2 and $\hat{\lambda}$ is the measure of loss aversion taken as the lower bound (upper bound, mid point) of the range of parameters for the relevant group in Table 3. Similarly, in the forced exchange condition, where not exchanging can be supported in PE based only on utility values, this is

$$P(Choice = Y)_{Forced} \quad = \quad \frac{\exp(\hat{Y})}{\exp(\hat{X}) + \exp(\hat{Y})}.$$

And the predicted treatment effect is calculated as

$$Prediction = P(Choice = Y)_{Forced} - P(Choice = Y)_{Baseline}.$$

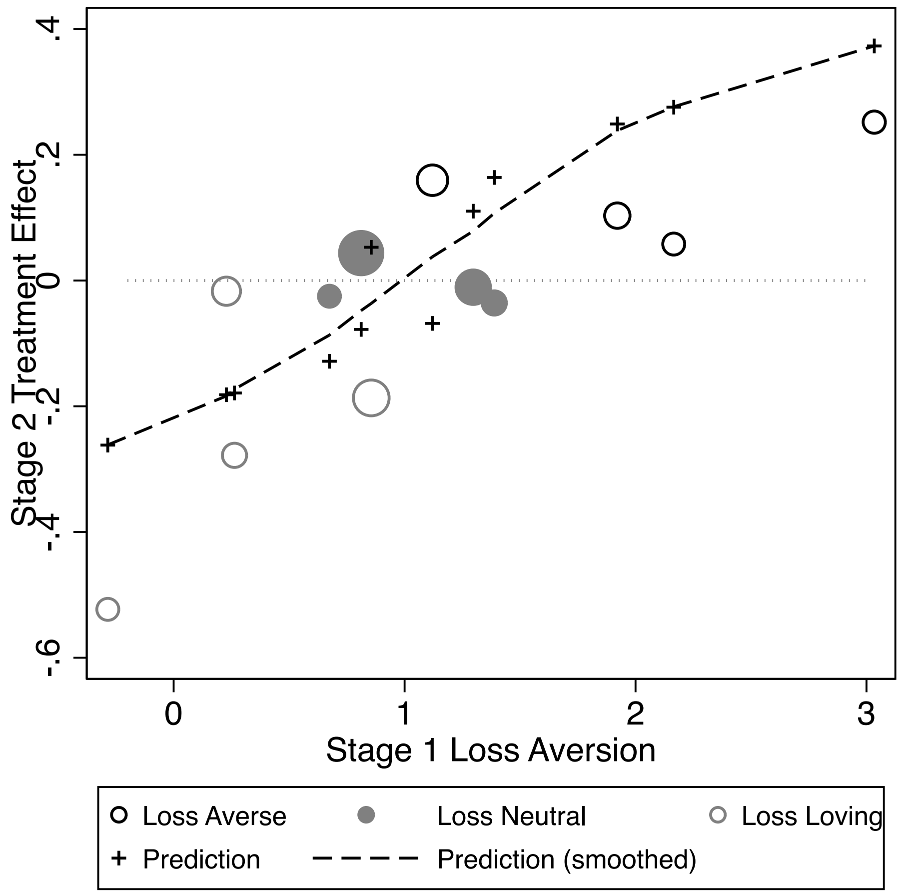

Figure 5: **Loss Aversion and Treatment Effects**

Notes: Stage 1 Loss Aversion corresponds to the lower bound (upper bound) of $\hat{\lambda}$ for those who prefer their own endowment (prefer the other good), and the midpoint for those who rate the goods the same. Treatment Effect refers to the difference in the probability of exchange between forced exchange and baseline. Circles represents the treatment effect for each group in the data, with size of circle corresponding to number of observations. *Prediction* uses the estimated structural parameters (at the relevant bounds and midpoints) to calculate the logit probability of exchange.

4.3 Additional Results: Subjective Experience and Exchange

The comparative statics and magnitude of treatment effects match well the theoretical developments. The taxonomy of loss aversion is respected in the responsiveness of behavior to forced exchange. Nonetheless, Table 5 highlights a marked reticence to exchange in the forced exchange condition overall . This 'residual' endowment effect falls outside the narrow predictions of the KR model, which, under our assumptions, would predict 50 percent exchange in this condition. In Table 6, we explore the effects of experience on subsequent exchange behavior by linking the variation in experience in Stage 1 to Stage 2 exchanges controlling for interactions between treatment and loss aversion type. Columns (1) and (4) of Table 6 show that actual experience of having their endowed object confiscated and replaced with the alternative in Stage 1 is not statistically related to exchange behavior in Stage 2. Controlling for the interaction of treatment and type, simply experiencing exchange via confiscation and replacement does not engender a greater willingness to exchange. If anything, the effects are directionally negative, with the experience of confiscation and replacement in Stage 1 leading to lower trading probabilities in Stage 2.

Table 6: **Stage 1 Experience and Stage 2 Exchange Behavior**

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Exchange (=1)					
Lost Stage 1 Endowment	-0.049		-0.033	-0.053		-0.038
	(0.039)		(0.039)	(0.039)		(0.040)
Δ Happiness (Stage 1)		0.020***	0.019**		0.020***	0.019**
		(0.007)	(0.007)		(0.007)	(0.007)
Constant	0.453	0.428	0.445	0.475	0.453	0.472
	(0.069)	(0.067)	(0.070)	(0.065)	(0.061)	(0.065)
Treatment X Structural Taxonomy	Yes	Yes	Yes	No	No	No
Treatment X Reduced Form Taxonomy	No	No	No	Yes	Yes	Yes
R-Squared	0.041	0.051	0.052	0.018	0.026	0.027
# Observations	607	607	607	607	607	607

Notes: Ordinary least squares or two-stage least squares regression. Robust standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In columns (2) and (5) of Table 6, we examine the correlation between subjective experience in Stage 1 and exchange behavior in Stage 2. Subjects with more positive subjective Stage 1 experiences are significantly more willing to exchange in Stage 2 controlling for type and treatment assignment. Columns (3) and (6) ensure that it is the subjective evaluation of this experience, rather than the objective event of confiscation that leads to changes in exchange behavior.

The findings of Table 6 highlight the importance of the subjective perception of experience. Objectively being forced to exchange seems less critical than the subjective representation of this experience for fostering future exchange. An understanding of the subjective perception of experience helps to evaluate research on the persistence of exchange anomalies like the endowment effect (List, 2003, 2004; Engelmann and Hollard, 2010). The view from this research indicates that the endowment effect is reduced by experiences of exchange, and even a minute body of experience (over the course of one experimental session in Engelmann and Hollard (2010)) can eliminate the phenomena. Our data show that it is not the objective experience of exchanging one item for another which fosters market participation, but rather it's subjective evaluation. Importantly, our results should not be read as inconsistent with those of Engelmann and Hollard (2010). Their design makes an explicit connection between exchange and positive experience as subjects must trade their endowed item in order to keep anything. As such trade is very likely to be viewed as subjectively positive and so naturally lead to increased trading behavior.[25] Beyond such short-term experiments, our data also help to contextualize longer-term results such as (List, 2003, 2004), who shows that more experienced traders are less likely to exhibit an endowment effect. Though exchange should, on average, be a positive experience, it need not be uniformly so. Our data indicate that negative subjective evaluations of exchange may slow the speed at which the endowment effect is eliminated by market experience.

5 Discussion and Conclusion

Expectations-based reference-dependent preferences (Kőszegi and Rabin, 2006) (KR) represent a key advance in behavioral economics, but a host of conflicting evidence for the theory exists. In this paper we aimed to reconcile this conflicting evidence by explicitly recognizing and evaluating heterogeneity in loss aversion. Heterogeneity is critical both because the model's comparative statics can change sign depending on the level of loss

[25]We discuss further differences in the implementation of trading experience between our design and the previous examination of Engelmann and Hollard (2010) in Appendix B.1.

aversion, and because prior work has noted that loss aversion is, by no means, a universal characteristic.

We measure loss aversion by evaluating ranking statements for a first bundle of goods without choice, and then place subjects in an exchange environment where they make choices over a second, different bundle of goods. We show that explicitly accounting for the heterogeneity in loss aversion by and large restores behavior in line with KR predictions. Individuals that are measured to be loss averse for the first bundle of goods deliver a substantial endowment effect for the second bundle, validating our taxonomy of types. Using a mechanism of probabilistic forced exchange, we then show that individuals who are measured to be loss averse grow more willing to exchange when probabilistically forced to do so; and individuals who are measured as loss loving grow less willing to exchange. These findings, and the magnitudes of the observed treatment effects are closely in line with the predictions of the KR model.

Our results help to reconcile conflicting results in the empirical study of the KR model (Ericson and Fuster, 2011; Heffetz and List, 2014; Goette et al., 2016) and follow naturally from the broad recognition of heterogeneity in loss aversion (Sprenger, 2015; Erev et al., 2008; Harinck et al., 2007; Nicolau, 2012; Sokol-Hessner et al., 2009; Knetsch and Wong, 2009; Chapman et al., 2017). If we are to recognize that loss aversion is not a universal trait, we must also recognize it as a confound of first-order importance for the KR model.

The conclusions drawn from this work rely on ex-ante measurement of the taxonomy of loss aversion. Though predicted and actual treatment effects generally coincide, our measures of loss aversion are admittedly broad. Future work could tighten the prediction using more refined measurements. Of course, more refined measurements come with potential challenges. If measurement is based on subject choices (e.g., for willingness to pay for lotteries), these choices themselves must be evaluated as part of a rational expectations equilibrium plan. Overcoming this joint challenge would represent a helpful advance over the current work.

Even accounting for KR forces, our data show a residual endowment effect of subjects being generally unwilling to exchange. Our results shed light on the mechanisms underlying such behavior. We show that unwillingness to exchange is related to prior experience, particularly the subjective perception thereof. Negative experience, regardless of objective outcome, leads to decreased exchange. This result may helpfully add to the literature on experience effects and exchange anomalies (List, 2003, 2004; Engelmann and Hollard, 2010), showing that exchange experience, even short-lived, can reduce the endowment effect. If the perception of experience influences subsequent exchange, it is possible for exchange anomalies to persist. Though exchange should generally be viewed as a positive event, with both parties gaining from trade, negative ex-post perceptions may still engender a hesitance to trade. Experiments which make explicit connection between trade and positive experience may thus be overstating the speed at which the endowment effect dissipates. And, provided that exchange is not a uniformly positive event, exchange anomalies may indeed persist with experience.

References

Abeler, Johannes, Armin Falk, Lorenz Goette, and David Huffman, "Reference points and effort provision," *The American Economic Review*, 2011, pp. 470–492.

Baucells, Manel and Rakesh K. Sarin, "Satiation in Discounted Utility," *Operations Research*, 2007, *55* (1), 170–181.

Bell, David E., "Disappointment in Decision Making under Uncertainty," *Operations Research*, 1985, *33* (1), 1–27.

Bradley, Margaret and Peter Lang, "Measuring emotion: the self-assessment manikin and the semantic differential," *Journal of behavior therapy and experimental psychiatry*, 1994, *25* (1), 49–59.

Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler, "Labor supply of New York City cabdrivers: One day at a time," *The Quarterly Journal of Economics*, 1997, pp. 407–441.

Cantillo, Víctor, Johanna Amaya, and Juan de Dios Ortúzar, "Thresholds and Indifference in Stated Choice Surveys," *Transportation Research Part B*, 2010, *44*, 753–763.

Chapman, Jonathan, Mark Dean, Pietro Ortoleva, Erik Snowberg, and Colin Camerer, "Willingness to Pay and Willingness to Accept are Probably Less Correlated Than You Think," Technical Report, National Bureau of Economic Research 2017.

DellaVigna, Stefano, Attila Lindner, Balázs Reizer, and Johannes F Schmieder, "Reference-dependent job search: evidence from Hungary," *The Quarterly Journal of Economics*, 2017.

Engelmann, Dirk and Guillaume Hollard, "Reconsidering the Effect of Market Experience on the 'Endowment Effect'," *Econometrica*, 2010, *78* (6), 2005–2109.

Erev, Ido, Eyal Ert, and Eldad Yechiam, "Loss aversion, diminishing sensitivity, and the effect of experience on repeated decisions," *Journal of Behavioral Decision Making*, 2008, *21* (5), 575–597.

Ericson, Keith M. Marzilli and Andreas Fuster, "Expectations as Endowments: Evidence on Reference-Dependent Preferences from Exchange and Valuation Experiments," *The Quarterly Journal of Economics*, 2011, *126* (4), 1879–1907.

Fehr, Ernst and Lorenz Goette, "Do Workers Work More When Wages Are High? Evidence from a Ranomized Field Experiment," *The American Economic Review*, 2007, *97* (1), 298–317.

Fischbacher, Urs, "z-Tree: Zurich toolbox for ready-made economic experiments," *Experimental economics*, 2007, *10* (2), 171–178.

Gneezy, Uri, Lorenz Goette, Charles Sprenger, and Florian Zimmermann, "The Limits of Expectations-Based Reference Dependence," *Journal of the European Economic Association*, Forthcoming.

Goette, Lorenz, Anette Harms, and Charles Sprenger, "Randomizing Endowments: An Experimental Study of Rational Expectations and Reference-Dependent Preferences," 2016. Unpublished Working Paper.

Harinck, Fieke, Eric Van Dijk, Ilja Van Beest, and Paul Mersmann, "When gains loom larger than losses reversed loss aversion for small amounts of money," *Psychological Science*, 2007, *18* (12), 1099–1105.

Heffetz, Ori and John A. List, "Is the Endowment Effect an Expectations Effect?," *Journal of the European Economic Association*, 2014, *12* (5), 1396–1422.

Kahneman, Daniel and Amos Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 1979, *47* (2), 263–291.

_ , Jack L. Knetsch, and Richard H. Thaler, "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy*, 1990, *98* (6), 1325–1348.

Kőszegi, Botond and Matthew Rabin, "A Model of Reference-Dependent Preferences," *The Quarterly Journal of Economics*, 2006, *121* (4), 1133–1165.

_ and _ , "Reference-Dependent Risk Attitudes," *The American Economic Review*, 2007, *97* (4), 1047–1073.

Knetsch, Jack and Wei-Kang Wong, "The endowment effect and the reference state: Evidence and manipulations," *Journal of Economic Behavior & Organization*, 2009, *71* (2), 407–413.

Lattin, J. M. and R. E. Bucklin, "Reference effects of price and promotion on brand choice behavior," *Journal of Marketing Research*, 1989, *26* (3), 299–310.

List, John A., "Does Market Experience Eliminate Market Anomalies?," *The Quarterly Journal of Economics*, 2003, *118* (1), 41–71.

_ , "Neoclassical Theory Versus Prospect Theory: Evidence from the Marketplace," *Econometrica*, 2004, *72* (2), 615–625.

Loomes, Graham and Robert Sugden, "Disappointment and Dynamic Consistency in Choice under Uncertainty," *Review of Economic Studies*, 1986, *53* (2), 271–82.

Markowitz, Harry, "The Utility of Wealth," *Journal of Political Economy*, 1952, *60* (2), 151–158.

McFadden, Daniel, "Conditional Logit Analysis of Qualitative Choice Behavior," in Paul Zarembka, ed., *Frontiers in Econometrics*, New York: Academic Press, 1974, chapter 4.

Nicolau, Juan L, "Asymmetric tourist response to price: loss aversion segmentation," *Journal of Travel Research*, 2012, *51* (5), 568–676.

Odean, Terrance, "Are Investors Reluctant to Realize Their Losses?," *The Journal of Finance*, 1998, *53* (5), 177–1798.

Plott, Charles R. and Kathryn Zeiler, "The Willingness to Pay-Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions and Experimental Procedures for Eliciting Valuations," *The American Economic Review*, 2005, *95* (3), 530–545.

_ **and** _ , "Exchange Asymmetries Incorrectly Interpreted as Evidence of Endowment Effect Theory and Prospect Theory?," *The American Economic Review*, 2007, *97* (4).

Putler, D. S., "Incorporating reference price effects into a theory of consumer choice," *Marketing Science*, 1992, *11* (3), 287–309.

Rabin, Matthew, "Risk Aversion and Expected Utility Theory: A Calibration Theorem," *Econometrica*, 2000, *68* (5), 1281–1292.

Shefrin, Hersh M. and M. Statman, "The disposition to sell winners too early and ride losers too long: Theory and evidence," *The Journal of Finance*, 1985, *40* (3), 777–790.

Sokol-Hessner, Peter, Ming Hsu, Nina G Curley, Mauricio R Delgado, Colin F Camerer, and Elizabeth A Phelps, "Thinking like a trader selectively reduces individuals' loss aversion," *Proceedings of the National Academy of Sciences*, 2009, *106* (13), 5035–5040.

Sprenger, Charles, "An endowment effect for risk: Experimental tests of stochastic reference points," *Journal of Political Economy*, 2015, *123* (6), 1456–1499.

Wathieu, Luc, "Habits and the Anomalies in Intertemporal Choice," *Management Science*, 1997, *43* (11), 1552–1563.

Appendix: Not for Publication

A Additional Analyses and Robustness Tests

A.1 Robustness Specifications

Below we display regression results with standard errors clustered at the session level. Tables A1 corresponds to Table 5 in the main text.

Table A1: **Exchange Behavior and Probabilistic Forced Exchange**
Clustered Standard Errors

	(1)	(2)	(3)	(4)
	Dependent Variable: Exchange (=1)			
	Full Sample	Loss Averse	Loss Neutral	Loss Loving
Panel A: Structural Bounds Taxonomy				
Probabilistic Forced Exchange	0.004	0.158***	0.027	-0.248***
	(0.034)	(0.050)	(0.071)	(0.060)
Baseline Exchange (Constant)	0.365	0.330	0.361	0.429
	(0.028)	(0.042)	(0.055)	(0.049)
R-Squared	0.000	0.025	0.001	0.072
# Observations	607	217	240	150
H_0: No Baseline Endowment Effect	$F_{1,605}$=23.85	$F_{1,215}$=16.44	$F_{1,238}$=6.30	$F_{1,148}$=2.13
	($p < 0.01$)	($p < 0.01$)	($p < 0.05$)	($p = 0.16$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=40.85	$F_{1,215}$=0.19	$F_{1,238}$=6.23	$F_{1,148}$ = 83.39
	($p < 0.01$)	($p = 0.67$)	($p < 0.05$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 1.95$
				($p = 0.16$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 25.61$
				($p < 0.01$)
Panel B: Reduced Form Taxonomy				
Probabilistic Forced Exchange	0.004	0.119**	-0.030	-0.149*
	(0.034)	(0.052)	(0.096)	(0.087)
Baseline Exchange (Constant)	0.365	0.304	0.392	0.448
	(0.028)	(0.032)	(0.070)	(0.076)
R-Squared	0.000	0.015	0.001	0.022
# Observations	607	285	131	191
H_0: No Baseline Endowment Effect	$F_{1,605}$=23.85	$F_{1,283}$=36.46	$F_{1,129}$=2.39	$F_{1,189}$=0.47
	($p < 0.01$)	($p < 0.01$)	($p = 0.13$)	($p = 0.50$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=40.85	$F_{1,283}$=3.46	$F_{1,129}$=4.25	$F_{1,189}$ = 22.79
	($p < 0.01$)	($p = 0.073$)	($p = 0.048$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 2.88$
				($p = 0.090$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 6.22$
				($p < 0.05$)

Notes: Ordinary least square regression. Standard errors clustered at session level in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Null hypotheses tested for 1) zero baseline endowment effect, regression (Constant = 0.5); 2) zero forced exchange endowment effect (Constant + Forced Exchange = 0.5); 3) Identical baseline behavior across loss averse and loss loving agents (Constant (col. 2) = Constant (col. 4)); 4) Identical treatment effects of forced exchange across loss averse and loss loving agents (Forced Exchange (col. 2) = Forced Exchange (col. 4)). Hypotheses 3 and 4 tested via seemingly unrelated regression. Panel A: taxonomy of types based on structural bounds from Table 3. Panel B: taxonomy of types based on reduced form rating statements from Table 3.

All analyses in the main text are based on a taxonomy of preference types based on liking scores. Below (Figure A1, Table A2, and Table A3) we report corresponding analyses for a categorization using the wanting scores elicited for the endowed and alternative good in Stage 1.

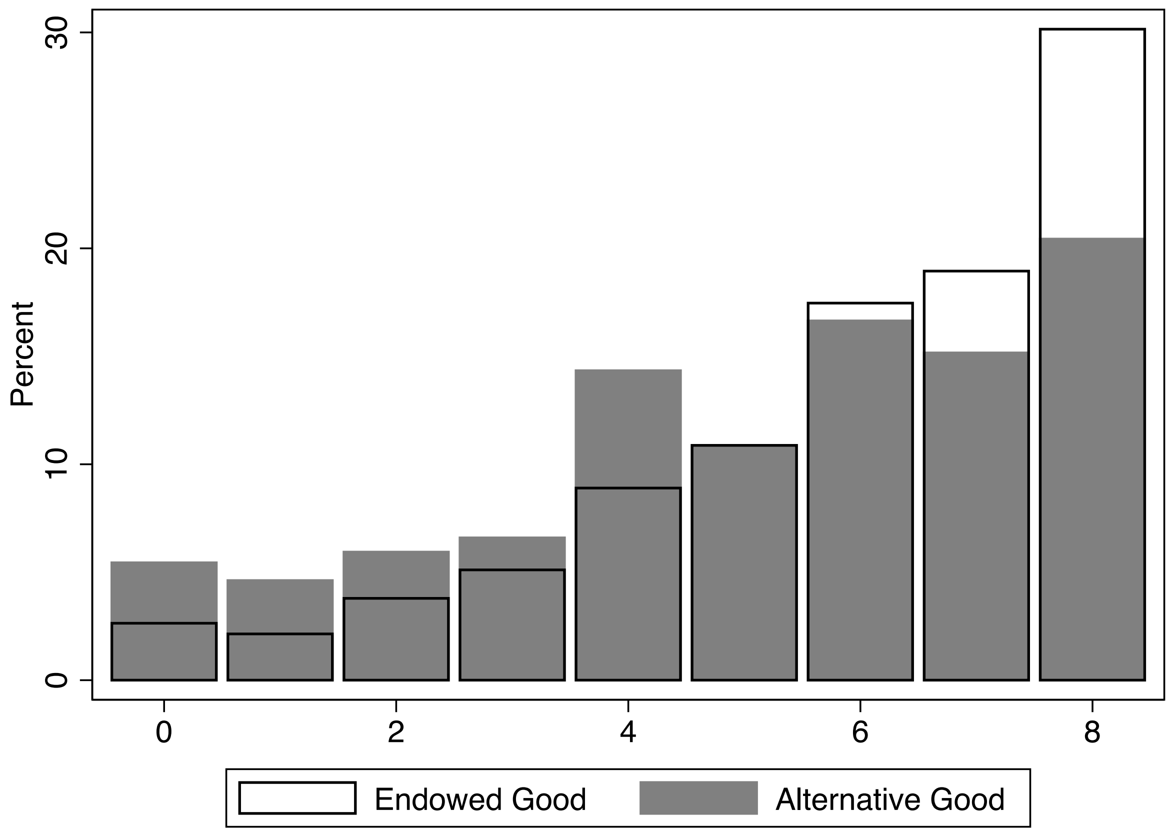

Figure A1: **Preferences and Endowments.** Self-reported scores of wanting for the endowed and alternative goods. (Wilcoxon signed-rank statistic $z = 5.86$ ($p < 0.01$), N=607).

Table A2: **Aggregate Parameter Estimates Based on Wanting Scores**

	(1)	(2)	(3)	(4)
	Estimate	(Std. Error)	Estimate	(Std. Error)
	Bundle 1		*Bundle 2*	
Loss Aversion:				
$\hat{\lambda}$	1.617	(0.132)	1.346	(0.113)
Utility Values:				
$\hat{X}_1$ *(Pen Set)*	0.674	(0.049)		
$\hat{Y}_1$ *(USB Stick)*	1	-		
$\hat{X}_2$ *(Picnic Mat)*			0.927	(0.050)
$\hat{Y}_2$ *(Thermos)*			1	-
Discernibility:				
$\hat{\delta}$	0.557	(0.060)	0.478	(0.053)

Notes: Maximum likelihood estimates. Robust standard errors in parentheses.

Table A3: **Exchange Behavior and Probabilistic Forced Exchange**
Type Categorization Based on Wanting Scores

	(1)	(2)	(3)	(4)
	Dependent Variable: Exchange (=1)			
	Full Sample	Loss Averse	Loss Neutral	Loss Loving
Panel A: Structural Bounds Taxonomy				
Probabilistic Forced Exchange	0.004	0.129**	-0.003	-0.177**
	(0.040)	(0.065)	(0.067)	(0.081)
Baseline Exchange (Constant)	0.365	0.327	0.383	0.407
	(0.032)	(0.048)	(0.054)	(0.067)
R-Squared	0.000	0.017	0.000	0.035
# Observations	607	223	239	145
H_0: No Baseline Endowment Effect	$F_{1,605}$=18.32	$F_{1,221}$=13.29	$F_{1,237}$=4.68	$F_{1,143}$=1.89
	($p < 0.01$)	($p < 0.01$)	($p < 0.05$)	($p = 0.17$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=27.48	$F_{1,221}$=0.97	$F_{1,237}$=9.62	$F_{1,143}$ = 36.65
	($p < 0.01$)	($p = 0.33$)	($p < 0.01$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 0.97$
				($p = 0.32$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 8.78$
				($p < 0.01$)
Panel B: Reduced Form Taxonomy				
Probabilistic Forced Exchange	0.004	0.103*	-0.093	-0.092
	(0.040)	(0.056)	(0.085)	(0.079)
Baseline Exchange (Constant)	0.365	0.297	0.439	0.431
	(0.032)	(0.042)	(0.066)	(0.065)
R-Squared	0.000	0.011	0.009	0.008
# Observations	607	293	138	176
H_0: No Baseline Endowment Effect	$F_{1,605}$=18.32	$F_{1,291}$=23.24	$F_{1,136}$=0.86	$F_{1,187}$=1.11
	($p < 0.01$)	($p < 0.01$)	($p = 0.36$)	($p = 0.29$)
H_0: No Forced Ex. Endowment Effect	$F_{1,605}$=27.48	$F_{1,291}$=7.24	$F_{1,136}$=8.40	$F_{1,187}$ = 13.50
	($p < 0.01$)	($p < 0.01$)	($p < 0.01$)	($p < 0.01$)
H_0: Baseline (col. 2) = Baseline (col. 4)				$\chi^2(1) = 3.01$
				($p = 0.08$)
H_0: Forced Ex. (col. 2) =Forced Ex(col. 4)				$\chi^2(1) = 4.12$
				($p < 0.05$)

Notes: Ordinary least square regression. Robust standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Null hypotheses tested for 1) zero baseline endowment effect, regression (Constant = 0.5); 2) zero forced exchange endowment effect (Constant + Forced Exchange = 0.5); 3) Identical baseline behavior across loss averse and loss loving agents (Constant (col. 2) = Constant (col. 4)); 4) Identical treatment effects of forced exchange across loss averse and loss loving agents (Forced Exchange (col. 2) = Forced Exchange (col. 4)). Hypotheses 3 and 4 tested via seemingly unrelated regression. Panel A: taxonomy of types based on structural bounds from wanting scores. Panel B: taxonomy of types based on reduced form rating statements from wanting scores.

B Comments on Related Literature

B.1 Engelmann and Hollard (2010)

In the laboratory study of Engelmann and Hollard (2010), subjects play three trading rounds prior to a final trading situation with the experimenter. They show that the endowment effect in the final (voluntary) exchange vanishes for those who have been forced to trade their endowed good in the training rounds, but persists for those who were allowed to voluntarily exchange during the training round. The implementation of forced trading in Engelmann and Hollard (2010) differs from ours in important ways. In the training rounds, subjects in the treatment group are forced to exchange in the sense that otherwise, they lose their endowed good and do not receive anything in return. If endowed with good X, subjects choose between a situation of exchanging X for good Y, and losing X without receiving Y either. This way, the training rounds, in a broad sense, 'condition' subjects to perceive exchange favorably by exposing them to the threat of leaving empty-handed. One explanation that reconciles their findings with our observation that the *subjective* perception of experience, i.e. its valence, determines subsequent willingness to trade, is that subjects who were forced to trade three times in a row in Engelmann and Hollard (2010) precisely grew more willing to trade because they learned to associate the no trade choice with not getting anything. Our notion of exchange – be it forced or voluntary – is motivated by typical trading situations and involves giving up the endowment *in return for something else*, instead of sacrificing the endowment for nothing in return. In any case, participants in the trade-it-or-lose-it design of Engelmann and Hollard (2010) were indeed more likely to make a subjectively positive experience than in our setting.[26]

Conceptually, Engelmann and Hollard (2010) attribute exchange asymmetries to 'trade uncertainty' about market procedures, specifically that individuals misperceive and exaggerate the costs or risks of market transactions absent experience. Even in the simple,

[26] A more critical interpretation is that training people to trade under the threat of losing leaving empty-handed otherwise is susceptible to experimenter demand effects because subjects could infer that the experimenter wants them to trade in the subsequent exchange situation.

stylized and short-lived experimental exchange setting, they suggest, people grow accustomed to trading in that the perceived risks or costs of trading decrease significantly.[27] While the notion of trade uncertainty is recognizably broad and potentially incorporates our valence finding, our experimental design attempts to eliminate potential sources of uncertainty about the trading mechanism by giving it a precise, transparent and simple structure, as well as by limiting social interaction.

[27] The training and second stages of Engelmann and Hollard (2010) still differ in important dimensions, however: The training rounds take place in a setting "without any restriction" where subjects can "interact, bargain, move, and so on" (Engelmann and Hollard, 2010, p.2008), while the final round is set in an isolated room facing the experimenter alone. The general setup is subject to a methodological criticism of laboratory exchange situations (Plott and Zeiler, 2005, 2007), because exchange is implemented as a direct social interaction that triggers, e.g., social comparison processes.

C Instructions and Material Presented to Participants

All instructions and information presented to participants have been translated from German to English.

C.1 Images of Objects Presented to Participants

The following images were projected to the wall of the lecture room at the beginning of the respective stage. For the displayed example, the Stage 1 bundle consisted of the USB stick and erasable pens, but this was counter-balanced at the session level.

Figure A2: **Image 1 Projected on the Wall to Present Objects.** For Stage 1 with goods bundle consisting of USB stick and erasable pens.

Figure A3: **Image 2 Projected on the Wall to Present Objects.** For Stage 2 with goods bundle consisting of thermos and picnic mat.

C.2 Instructions (computer-based)

Welcome to part 1 of 2 in this experiment!

Please close the curtain of you cabin and read the following information. All computer entries that you make in this experiment are fully anonymous and cannot be traced back to you. Speed is not important at any point in this experiment. Please always take sufficient time to read and understand the instructions.

The [USB stick / erasable pens / thermos / picnic mat] now belongs to you. You can touch and inspect it at any time. However, please do not yet open the packaging and do not use the object yet. The two objects presented to you ([USB stick and erasable pens / thermos and picnic mat]) have been randomly allocated to the cabins in equal quantities. Your cabin number was also randomly determined based on your choice of seat in the presentation room.

Please click on OK when you have read these information. If you have questions, please call an experimenter.

Please answer the questions.

[USB stick / thermos]

How much do you like this product?

How much would you want to have this product?

[Erasable pens / picnic mat]

How much do you like this product?

How much would you want to have this product?

Please read the following information carefully.

The experimenter will soon draw a random number between 1 and 20 using a lotto drum. The drawn number will then be announced loudly. If the drawn number is a number [from 11 to 20 / from 1 to 10], your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]. If the drawn number is a number [from 1 to 10 / from 11 to 20], you will keep your [USB stick / erasable pens / thermos / picnic mat] and nothing happens. After the number has been drawn and the exchange of objects has taken place (if applicable), nothing else happens in this part of the experiment. You can then keep your object for good.

Please only confirm below once you have understood everything. If you have questions, please call the experimenter and wait until he comes to your cabin.

[Mood elicitation 1]

Please answer the following questions about how you currently feel. Which expressions better apply to you at the moment?

"Unhappy, Angry, Unsatisfied, Sad, Desperate" – "Happy, Thrilled, Satisfied, Content, Hopeful"

The time has come. Please wait until the number has been drawn.

Remember: If the drawn number is a number [from 11 to 20 / from 1 to 10], your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]. If the drawn number is a number [from 1 to 10 / from 11 to 20], you will keep your [USB stick / erasable pens / thermos / picnic mat].

The drawn number is [1 / 2 / ... / 20].

This number is a number [from 1 to 10 / from 11 to 20]. Therefore [you can keep your [USB stick / erasable pens / thermos / picnic mat] / your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]]. Please wait while the experimenter carries out the exchange in all cabins.

[Mood elicitation 2 and control question.]

Please answer the following questions about how you currently feel. Which expressions better apply to you at the moment?

"Unhappy, Angry, Unsatisfied, Sad, Desperate" – "Happy, Thrilled, Satisfied, Content, Hopeful"

Regarding the lottery draw, that has just taken place: What was the probability (in percent) that you would lose your initial object? Please enter a number between 0 and 100.

Part 1 of the experiment is over!

Please follow the instructions.

- Memorize your cabin number.
- You can no go back to the presentation room.
- Please leave your [USB stick / erasable pens / thermos / picnic mat] in the cabin. You will be back in the same cabin in a few minutes.
- Remember: The object now belongs to you for good and you will take it away from this experiment.

Welcome to part 2 in this experiment!

Please close the curtain of you cabin and read the following information. The [USB stick / erasable pens / thermos / picnic mat] now also belongs to you. You can touch and inspect it at any time. However, please do not yet open the packaging and do not use the object yet. The two objects presented to you for part 2 ([USB stick and erasable pens / thermos and picnic mat]) have again been randomly allocated to the cabins in equal quantities.

Please click on OK when you have read these information. If you have questions, please call an experimenter.

[Instructions Stage 2 – ONLY BASELINE (p=0.0)]

Please read the following information carefully. The [USB stick / erasable pens / thermos / picnic mat] from part 2 of the experiment now belongs to you and you can keep it for good. If you like, you can exchange your [USB stick / erasable pens / thermos / picnic mat] voluntarily for [USB stick / erasable pens / thermos / picnic mat]. Whichever way you decide, your choice is final and you will take your selected object with you from this experiment.

Please only confirm below once you have understood everything. If you have questions, please call the experimenter and wait until he comes to your cabin.

[Instructions Stage 2 – ONLY FORCED EXCHANGE (p=0.5)]

Please read the following information carefully. You have received a new object in part 2 of the experiment ([USB stick / erasable pens / thermos / picnic mat]). You will soon get the opportunity to exchange your [USB stick / erasable pens / thermos / picnic mat] voluntarily for [USB stick / erasable pens / thermos / picnic mat].

If you decide to exchange, you will receive [USB stick / erasable pens / thermos / picnic mat] as requested for your [USB stick / erasable pens / thermos / picnic mat] and you can then keep your [USB stick / erasable pens / thermos / picnic mat] for good. The experiment is then finished.

If you decide against an exchange, there will be a probability of 50% that the exchange will be forced anyways and you have to exchange nevertheless.

Concretely, the following happens in the case that you decide against a voluntary exchange: The experimenter will draw a random number between 1 and 20 using a lotto drum (as in part 1 of the experiment). The drawn number will then be announced loudly. If the drawn number is a number [from 11 to 20 / from 1 to 10], your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]. If the drawn number is a number [from 1 to 10 / from 11 to 20], you will keep your [USB stick / erasable pens / thermos / picnic mat] and nothing happens. After the number has been drawn and the exchange of objects has taken place (if applicable), nothing else happens in this part of the experiment. You can then keep your object for good.

Please only confirm below once you have understood everything. If you have questions, please call the experimenter and wait until he comes to your cabin.

[Mood elicitation 3]

Before you get the opportunity to exchange your object, please answer the following questions about how you currently feel. Which expressions better apply to you at the moment? "Unhappy, Angry, Unsatisfied, Sad, Desperate" – "Happy, Thrilled, Satisfied, Content, Hopeful"

Do you want to exchange your [USB stick / erasable pens / thermos / picnic mat] for a [USB stick / erasable pens / thermos / picnic mat]?

Yes, I want to exchange.

No, I do not want to exchange.

[ONLY BASELINE (p=0.0)]

You have decided [for / against] a voluntary exchange. Please wait while the experimenter carries out the exchange in all cabins.

[ONLY FORCED EXCHANGE (p=0.5)]

You have decided [for / against] a voluntary exchange. Please wait while the experimenter carries out the exchange in all cabins.

[ONLY NON-TRADERS] After this, it will be determined whether you have to exchange anyways.

[ONLY TRADERS] Please wait until the experiment continues. A random number will now be drawn for those who decided against a voluntary exchange. After that the experiment continues for you.

[ONLY NON-TRADERS] Remember: If the drawn number is a number [from 11 to 20 / from 1 to 10], your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]. If the drawn number is a number [from 1 to 10 / from 11 to 20], you will keep your [USB stick / erasable pens / thermos / picnic mat].
[ONLY NON-TRADERS]
The drawn number is [1 / 2 / ... / 20]
This number is a number [from 1 to 10 / from 11 to 20]. Therefore [you can keep you [USB stick / erasable pens / thermos / picnic mat] / your [USB stick / erasable pens / thermos / picnic mat] will be taken away from you and you instead receive [USB stick / erasable pens / thermos / picnic mat]. Please wait while the experimenter carries out the exchange in all cabins.

[Mood elicitation 4]

Please answer the following questions about how you currently feel. Which expressions better apply to you at the moment?
"Unhappy, Angry, Unsatisfied, Sad, Desperate" – "Happy, Thrilled, Satisfied, Content, Hopeful"

The experiment is over!

You can keep both your objects. You will also receive a show-up fee of 4 euros. Please wait shortly in you cabin until the experimenter calls you out. Thank you for your participation!